

VIII. *A Delineation of the Transfit of Venus expected in the Year 1769, by Mr. James Ferguson.*

*To the Right Honourable the Earl of Macclesfield,  
President of the Royal Socie'y.*

My Lord,

Read Feb. 10, 1763. **I** Beg leave to present to the Royal Society a delineation of the transfit of Venus in the year 1769 [TAB. I.] which will be a much better transfit for discovering the Sun's parallax than that in 1761 was.

Although I have only mentioned Wardhuys in Norwegian Lapland, and the Solomon isles in the great South Sea, as proper places for observing that transfit; yet I am sensible, that any other place near the north cape will be just as well for the northern observers; and Tuberon's Isle, or St. Bernard's, or the Fly Islands, in the great South Sea, will answer as well for the Southern.

Although it cannot be expected, that any delineation can be so exact as calculation, yet I hope this projection will be found to come very near the truth; and am, with the highest respect,

My Lord

your Lordship's

and the Royal Society's

most obliged humble servant

James Ferguson.

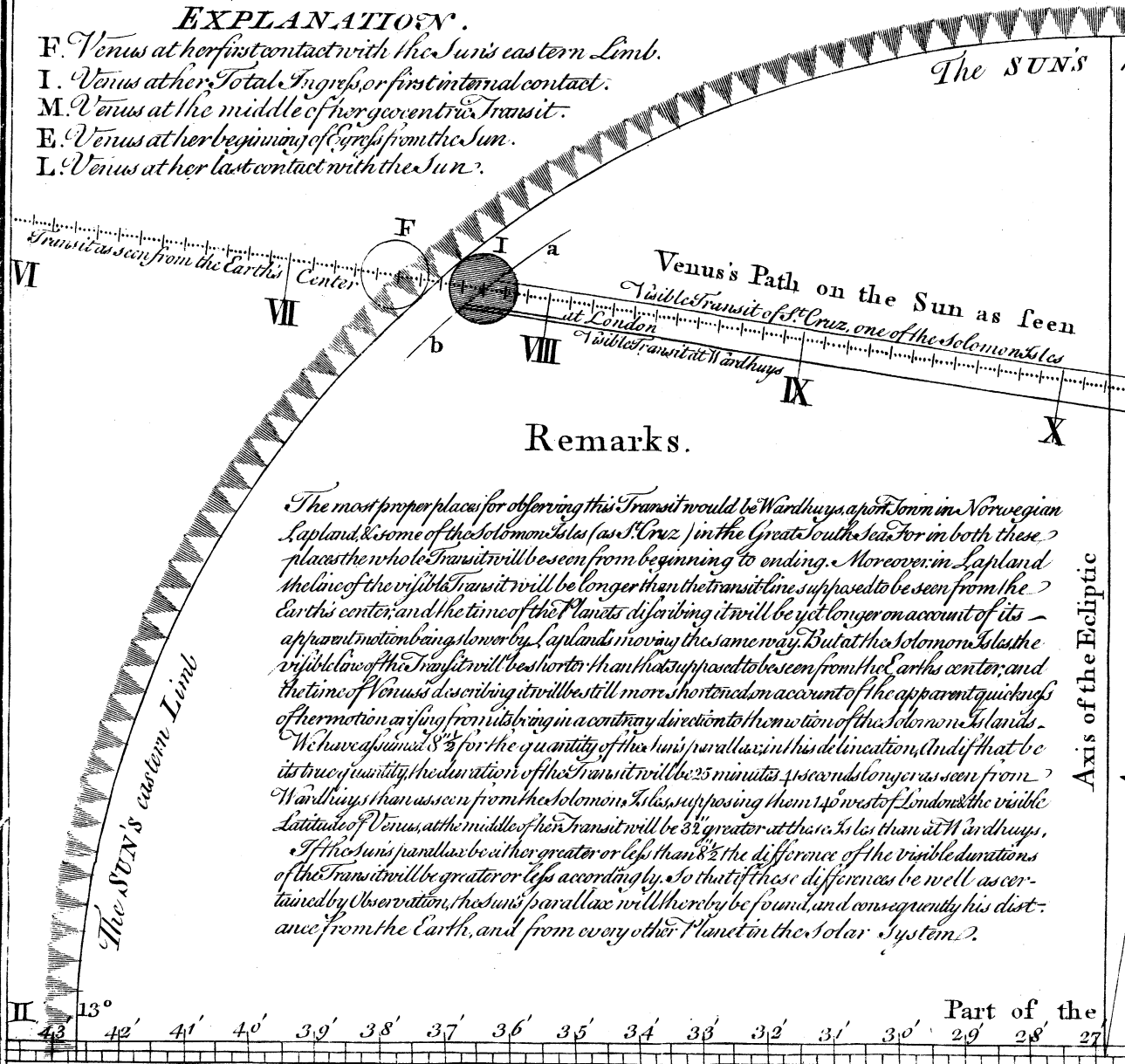
Mortimer-Street,  
Feb. 10, 1763.

IX. *An*

# The TRANSIT of VENUS over the SUN, June 3<sup>d</sup> 1769, Delineated by James Ferguson.

## EXPLANATION.

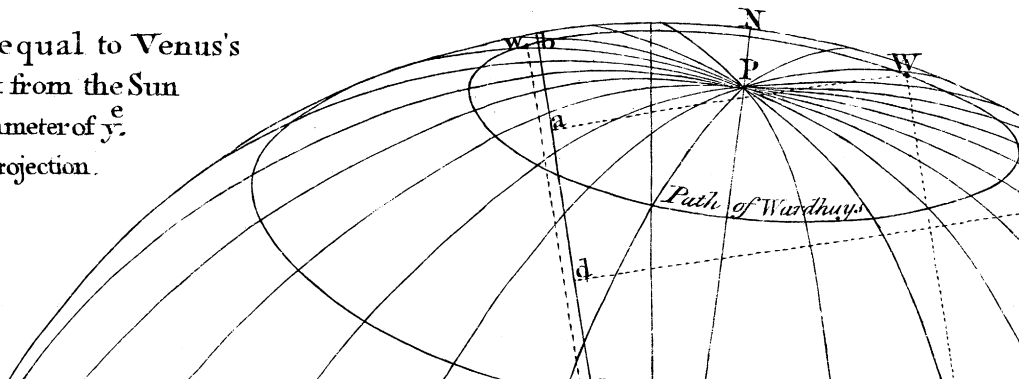
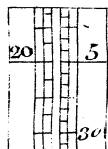
- F. Venus at her first contact with the Sun's eastern Limb.  
 I. Venus at her Total Ingress, or first internal contact.  
 M. Venus at the middle of her geocentric Transit.  
 E. Venus at her beginning of Egress from the Sun.  
 L. Venus at her last contact with the Sun.



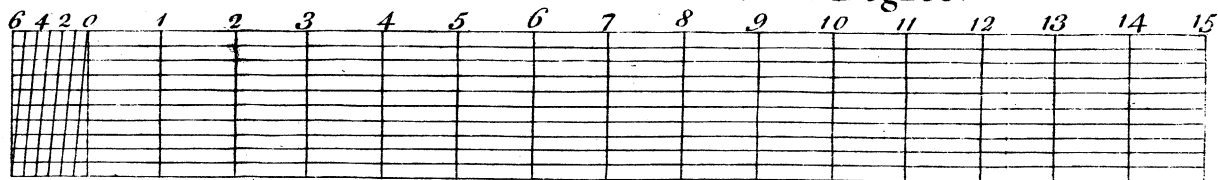
## Remarks.

The most proper places for observing this Transit would be Wardhuys, a port town in Norwegian Lapland, & some of the Solomon Islands (as S. Cruz) in the Great South Sea. For in both these places the whole Transit will be seen from beginning to ending. Moreover, in Lapland the line of the visible Transit will be longer than the transit line supposed to be seen from the Earth's center, and the time of the Planets describing it will be yet longer on account of its apparent motion being slower by Lapland's moving the same way. But at the Solomon Islands the visible line of the Transit will be shorter than that supposed to be seen from the Earth's center, and the time of Venus's describing it will be still more shortened on account of the apparent quickness of her motion arising from its being in a contrary direction to the motion of the Solomon Islands. We have assumed  $8\frac{1}{2}$  for the quantity of the Sun's parallax in this delineation, and if that be its true quantity, the duration of the Transit will be 25 minutes & 3 seconds longer as seen from Wardhuys than as seen from the Solomon Islands, supposing them 14° west of London, & the visible Latitude of Venus at the middle of her Transit will be  $3\frac{1}{2}$  greater at these Islands than at Wardhuys. If the Sun's parallax be either greater or less than  $8\frac{1}{2}$  the difference of the visible durations of the Transit will be greater or less accordingly, so that if these differences be well ascertained by Observation, the Sun's parallax will thereby be found, and consequently his distance from the Earth, and from every other Planet in the Solar System.

Scale of  $21''.3$ , equal to Venus's horizontal Parallax from the Sun and to the Semidiameter of  $\frac{e}{y}$  Earth's Disc in this Projection.

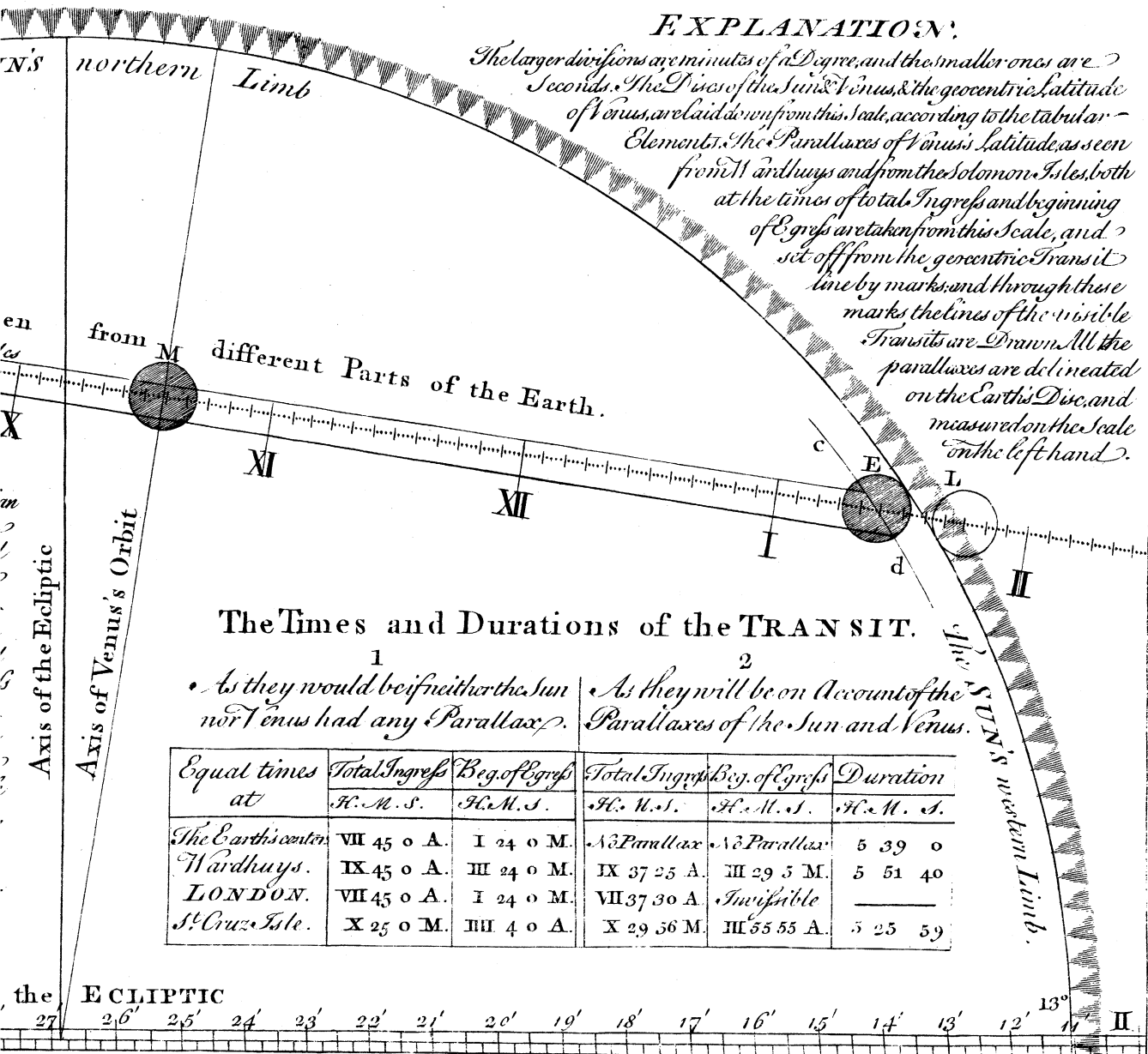


# Scale of Minutes and Seconds of a Degree.



## EXPLANATION.

The larger divisions are minutes of a Degree, and the smaller ones are Seconds. The Places of the Sun & Venus, & the geocentric Latitude of Venus, are laid down from this Scale, according to the tabular Elements. The Parallaxes of Venus's Latitude, as seen from M and Huys and from the Solomon Isles, both at the times of total Ingress and beginning of Egress are taken from this Scale, and set off from the geocentric Transit line by marks, and through these marks the lines of the visible Transits are Drawn. All the parallaxes are delineated on the Earth's Disc, and measured on the Scale on the left hand.



## The Times and Durations of the TRANSIT.

1  
As they would be if neither the Sun nor Venus had any Parallax.

2  
As they will be on Account of the Parallaxes of the Sun and Venus.

Equal times at	Total Ingress H. M. S.	Reg. of Egress H. M. S.	Total Ingress H. M. S.	Reg. of Egress H. M. S.	Duration H. M. S.
The Earth's center	VII 45 0 A.	I 24 0 M.	As Parallax	As Parallax	5 39 0
Wardhuys.	IX 45 0 A.	III 24 0 M.	IX 37 25 A.	III 29 5 M.	5 51 40
LONDON.	VII 45 0 A.	I 24 0 M.	VII 37 30 A.	Twifible	—
St. Cruz Isle.	X 25 0 M.	III 4 0 A.	X 29 36 M.	III 55 55 A.	5 25 59

An Orthographical Projection of the Earth's enlightened Disc as seen from the SUN during the time of the TRANSIT.

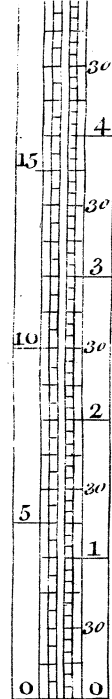
## EXPLANATION.

N.B. The Earth's enlightened Disc, on which are delineated the Equator, Tropics, &c. is seen from the Sun, & the Sun's western Limb is shown on the right hand.

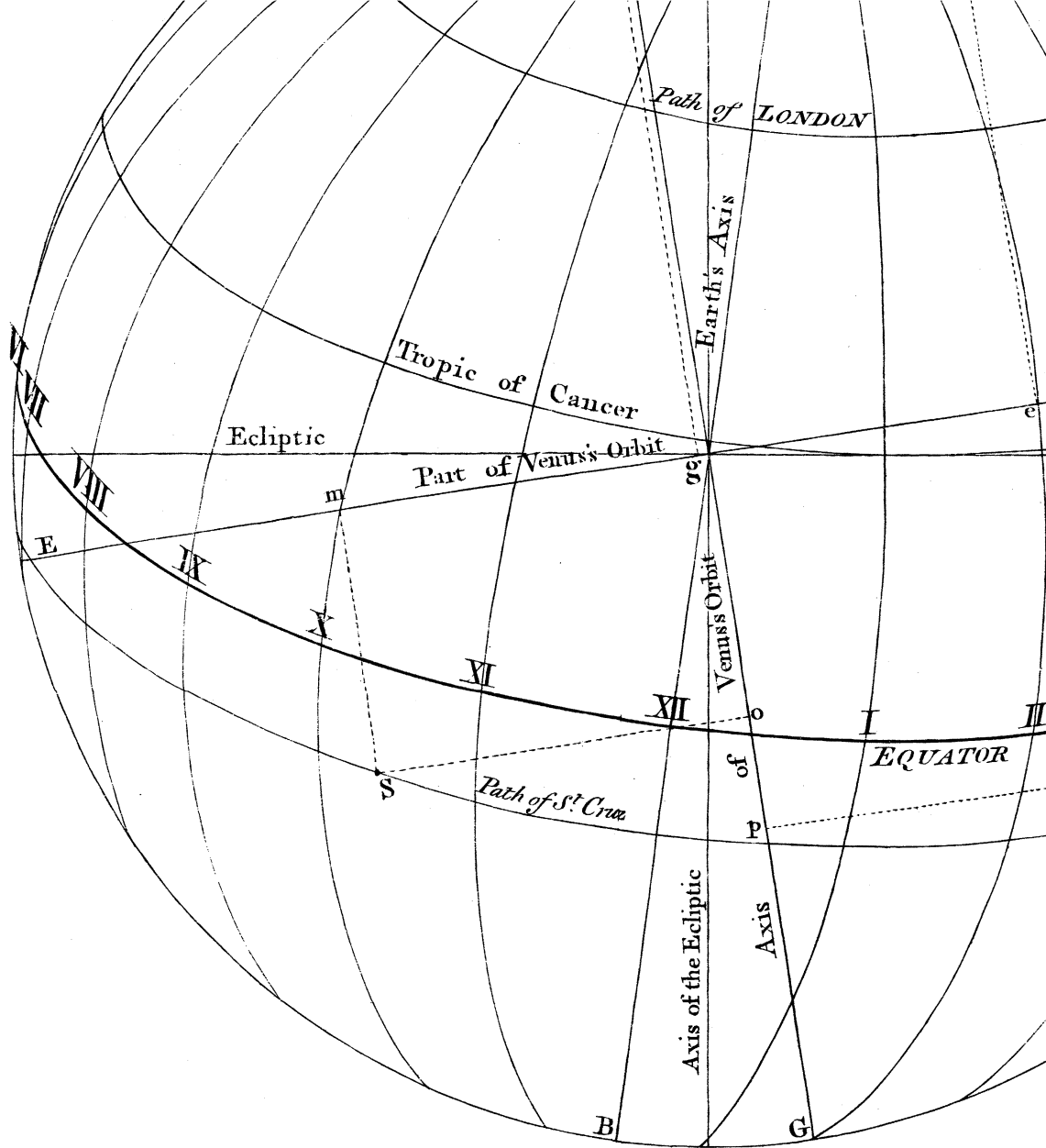
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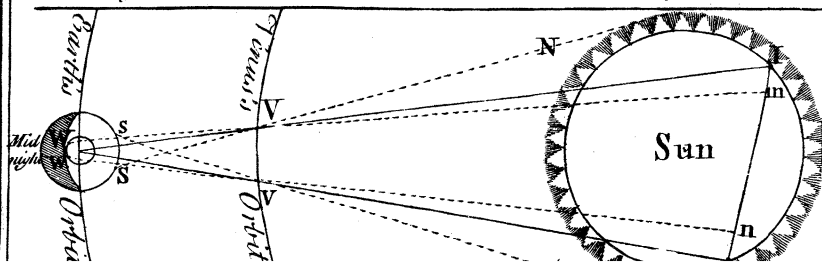


Seconds of a Degree Venus's horizontal parallax from the Sun  
Minutes and seconds of time answering to that parallax

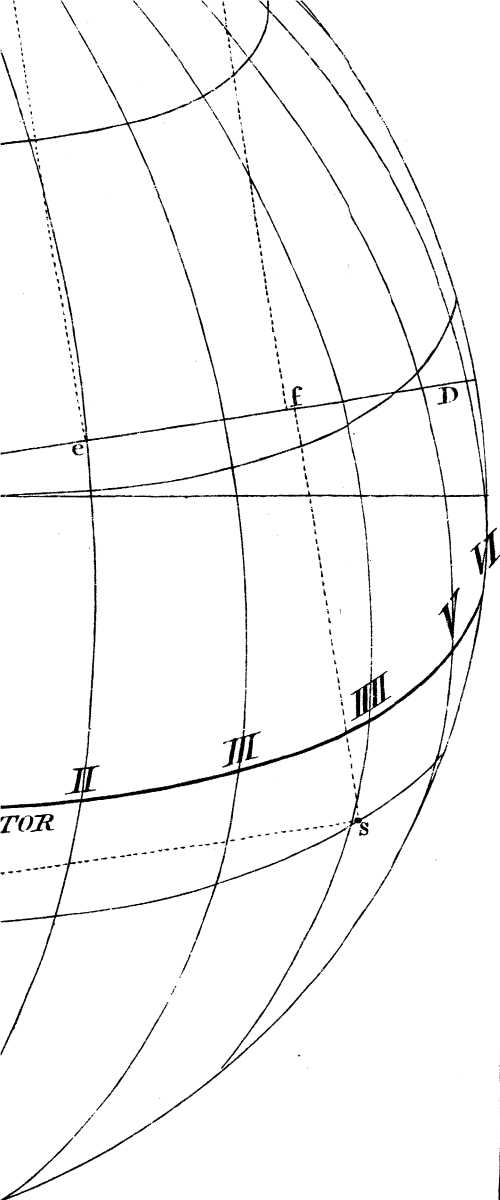


## The Elements from which these Projections are deduced

- |   |   |  |
|---|---|--|
| 1. True time at Greenwich of Conjunction of the Sun & Venus June 2...     | D. H. M. S.   | 11. The Sun's horizontal parallax, assumed   |
| 2. Their true Places in the Ecliptic then as seen from the Earth's center | 2. 13. 26. 51   | 12. And consequently, Venus's horizontal     |
| 3. The Sun's Declination North  | 22. 27. 20  | 13. Their difference = Venus's horizontal    |
| 4. The Place of Venus's Ascending Node                                    | 2. 14. 36. 14   | 14. The Sun's Semidiameter                   |
| 5. Her Geocentric Latitude at that time, North Descending                 | 10. 22  | 15. Venus's Semidiameter                     |
| 6. The Angle of her visible path with the Ecliptic                        | 8. 30. 10   | 16. Latitude of Wardhus North                |
| 7. Her Geocentric homary motion on (or from) the Sun                      | 3. 59. 1/2  | 17. Its Longitude East from London           |
| 8. The Sun's distance from the Earth                                      | { 101523 } The Sun's mean distance<br>{ 72627 } from the Earth's center<br>{ 28896 } being 100000 of such parts | 18. Latitude of London North                 |
| 9. Venus's distance from the Sun  |   | 19. Latitude of St. Cruz, one of the Solomon |
| 10. Her distance from the Earth   |   | 20. Its Longitude West from London, supposed |



**EXPLANATION.** In this Diagram, S turns on its Axis according to the order in her Orbit at V, she will appear upon it as seen from the Earth's center, but at the Isle at S, she will be in the line SVN, as then seen from Wardhus at W, she The Sun at m, so that her total Ingress hays, & later, as seen from St. Cruz, than as seen



N I B. The Earth's enlightened Disc, on which are delineated the Equator, Tropics of Cancer, diurnal Paths of Wardhuys.. London, Island of S.<sup>t</sup> Cruz, as seen from the Sun, and the Parallaxes of Venus's longitude and latitude as seen from those Places, at y times of Venus's two internal contacts with the Sun.

E g D. A small part of Venus's Orbit, and b g G its Axis.

N g B. The Earth's Axis and Universal Meridian. P its North Pole.

W..... The situation of Wardhuys on the Earth's Disc as seen from the Sun at the time of Venus's total Ingress as seen from the Earth's Center: & w the situation of Wardhuys when Venus's Egress from the Sun begins.

W a..... Venus's Parallax in Longitude =  $10^{\circ} 24'$  westward as seen from Wardhuys at the time of her total Ingress on the Sun as seen from the Earth's center, and W e her Parallax in Latitude =  $18^{\circ} 28'$  southward at that time.

W b..... Venus's Parallax in Longitude =  $2^{\circ}$  eastward, as seen from Wardhuys at the time when her Egress from the Sun begins, as seen from the Earth's center, and W g, her Parallax in Latitude, =  $21^{\circ} 24'$  southward, at that time.

L..... The situation of London on the Earth's Disc, as seen from the Sun at the time of Venus's total Ingress as seen from the Earth's center.

L d..... Venus's Parallax in Longitude =  $16^{\circ}$  Westward, as seen from London at the time of her total Ingress as seen from the Earth's center; and L f her Parallax in Latitude, =  $14^{\circ} 2'$  at that time. Her Egress is invisible at London.

S..... The situation of S.<sup>t</sup> Cruz Isle on the Earth's Disc as seen from the Sun at the time of Venus's total Ingress as seen from the Earth's center; and s, the situation of S.<sup>t</sup> Cruz when Venus's Egress from the Sun begins.

S o..... Venus's Parallax in Longitude =  $11^{\circ} 32'$  Eastward, as seen from S.<sup>t</sup> Cruz at the time of Venus's total Ingress as seen from the Earth's center; & S m her Parallax in Latitude, =  $8^{\circ} 32'$  at that time, North.

s p..... Venus's Parallax in Longitude =  $16^{\circ} 4'$  Westward, as seen from S.<sup>t</sup> Cruz at the time when her Egress begins as seen from the Earth's Center, and s f her Parallax in Latitude =  $12^{\circ} 2'$  northward at that time.

All these Parallaxes are measured on the Scale at the left hand; and the times by which the total Ingress of Venus, & her beginning of Egress, are accelerated or retarded by her Parallax in Longitude, are found in the Scale, right against that Parallax. An eastern Parallax in Longitude retards the Ingress or Egress as seen from any given place, with respect to the time thereof as seen from the Earth's center, and a western Parallax in Longitude accelerates it. A northern Parallax in Latitude retards the time of Ingress, as seen from any given place, & accelerates the time of Egress, by the number of Minutes that the half-transit Line on the Sun's Disc is shorter as seen from the given place than as seen from the Earth's center, when Venus passeth above the Sun's center, as in this Transit; & a Southern Parallax in Latitude accelerates the Ingress, and retards the Egress, as seen from any given place, with respect to the time thereof as seen from the Earth's center, by the number of Minutes that the half-transit line on the Sun is longer as seen from the given place than as seen from the Earth's center. And these differences are found by measuring with Compasses in the above Figure of the Sun's Disc, from the Axis of Venus's Orbit to the Arc a b where Venus's center is at the instant of total Ingress; and to the Arc c d where her center is when her Egress begins. And thus, the times of total Ingress, and beginning of Egress as seen from the above mentioned places, were found, as expressed in the Table of the Times and Durations of the Transit.

## deduced.

assumed to be 2.....	0.00.8.5
horizontal parallax.....	0.00.29.8
horizontal parallax from the Sun.....	0.00.21.3
.....	0.15.45.5
.....	0.00.29.5
North.....	71.00.0
m. London (in Time 2 hours).....	30.00.0
North.....	51.30.0
Solomon Isles/South supposed to be.....	11.00.0
don, supposed to be (in time 9 <sup>h</sup> .20 <sup>m</sup> ).....	140.00.0

Diagram S s W w represents the Earth, which in the order of the Letters. When Venus is upon the Sun at I, at her total Ingress, but at the same time, as seen from S.<sup>t</sup> Cruz she is V N, not entered upon the Sun; and at W, she will appear to be advanced upon the Sun, so that her Ingress will be sooner, as soon from Wardhuys, than as seen from the Earth's center.

As Venus moves from V to w in her Orbit, S.<sup>t</sup> Cruz moves the contrary way, from S to s, and Wardhuys the same way, from W to w. When Venus is at v in her Orbit, she will appear on the Sun at E, at her beginning of Egress, as seen from the Earth's center; but at that time, she will be quite clear of the Sun, in the line s v O, as seen from S.<sup>t</sup> Cruz then at S; and as seen from Wardhuys, then at w, she will appear on the Sun at n, shortly after her beginning of Egress, which will be later at Wardhuys and sooner at S.<sup>t</sup> Cruz, than as seen from the Earth's center.

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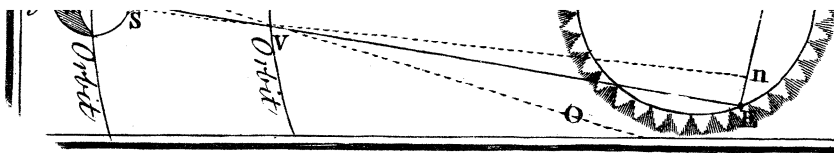
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 hurs, & later, as seen from St. Cruz, than as seen



at  $S \times S$ , will be seen upon the sun, and  
at  $W$ , she will appear to be advanced upon  
the Ingress will be sooner, as soon from Ward-  
an as seen from the Earth's center. —

near of the sun, in the line  $S \times S$ , as seen from  $M$ . Cruz then at  $S$ ; and  
as seen from Wardhuys. Then at  $W$ , she will appear on the sun at  $n$ . short  
of her beginning of Egress, which will be later at Wardhuys and sooner at  
St. Cruz, than as seen from the Earth's center. —

*J. Mynde, sc.*

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---	---	---	---	---	---	---	---	---	---	---	---	---	----	----	----	----	----	----

F. Venus at her first contact with the Sun's eastern Limb.  
I. Venus at her Total Eclipses or first internal contact.  
M. Venus at the middle of her greatest Transit.  
E. Venus at her beginning of Egress from the Sun.  
L. Venus at her last contact with the Sun's.

The larger divisions are minutes of a Degree, and the smaller ones are Seconds. The *Poles* of this *Sun's* *Transit*, and the *geocentric* *Latitude* of *Venus*, are laid down from this *Scale*, according to the *tabular Elements*. The *Parallaxes* of *Venus's* *Latitude*, as seen from *M*, and *happens* from the *Solomon-Islands*, both at the *times* of *total* *Ingrefs*, and beginning of *Egrefs*, are taken from this *Scale*, and set off from the *geocentric* *Transit* line by marks, and through those marks the *lines* of the *visible* *Transits* are *Drawn*. All the *parallaxes* are delineated on the *Earth's* *Disk*, and measured on the *Scale* in the left hand.

The most proper place for observing this Transit would be Wardhus, a spot known in Norwegian Lapland, & some of the Solomon Islands (an' Croz) in the Great South Sea for in both these places the whole Transit will be seen from beginning to ending. Moreover, in Lapland the line of the visible Transit will be longer than the transit line, supposed to be seen from the Earth's center; and the time of that Transit deflected it will be yet longer on account of its apparent motion being slower by Lapland's moving the same way. But at the Solomon Islands the visible Transit will be shorter than that supposed to be seen from the Earth's center, and the time of Venus's descending it will still more shortened on account of the apparent quickness of her motion arising from it being in a contrary direction to the motion of this known Islands. We have a good  $8^{\circ}$  for the quantity of this hour's parallel in this declination, & find that be it true in quantity the duration of this Transit will be 33 minutes 3 seconds longer as seen from Wardhus than as seen from the Solomon Islands supposing them to be west of London the visible Latitude of Venus at the middle of this Transit will be  $32^{\circ}$  greater at than less than at N in drugs. If the hour's parallel be either greater or less than  $8^{\circ}$  the difference of the visible durations of the Transit will be greater or less accordingly, so that if these differences be well ascertained by Observation, the hour's parallel will then be found, and consequently his distance from the Earth, and from every other Planet in the Solar System.

1 2

• As they would be if neither the Sun nor Venus had any Parallax. • As they will be on Account of the Parallaxes of the Sun and Venus

Equal times at	Total Ingress	Big of Ingress	Total Ingress	Big of Ingress	Duration
	H. M. S.	H. M. S.	H. M. S.	H. M. S.	
The Earth's centre	VII 45 0 A.	I 24 0 M.	IX 37 25 A.	III 29 5 M.	5 39 0
Wardhuys.	IX 45 0 A.	III 24 0 M.	VII 37 30 A.	IX 37 30 A.	5 51 40
LONDON.	VII 45 0 A.	I 24 0 M.	IX 37 30 A.	IX 37 30 A.	5 51 40
S. Cruz, Isle.	X 25 0 M.	III 4 0 A.	X 29 36 M.	III 55 55 A.	5 25 39

An Orthographical Projection of the Earth's  
enlightened Disc as seen from the SUN  
during the time of the TRANSIT.

N. I. B. *The Earth's enlightened Disk, on which are delineated the Equator, Tropics of Cancer, several Paths of Warthugs*. London. *Island of St. Vincent as seen from the Sun* and the parallaxes of Venus's longitude and latitude as seen from those Places, at 5 times of Venus's two internal contacts with the Sun.

E g D. A small part of Venus's Orbit: and h g G do Axis.  
N B. The Earth's Axis and Universal Meridian. P is the North Pole.  
W..... The situation of Wardhays on the Earth's Disc as seen from the Sun at the time of Venus's total Egress as seen from the Earth's Center: & W w the situation of Wardhays when Venus Egress from the Sun begins  
W a..... Venus's Parallax in Longitude =  $10^{\circ} \frac{1}{2}$  westward as seen from Wardhays at the time of her total Egress on the Sun as seen from the Earth's Center, and W e her Parallax in Latitude =  $18^{\circ} \frac{3}{4}$  southward at that time.  
W b..... Venus's Parallax in Longitude =  $^{\circ} 2$  eastward as seen from Wardhays at the time when her Egress from the Sun begins as seen from the Earth's center, and W g, her Parallax in Latitude =  $21^{\circ} \frac{1}{4}$  southward, at that time.  
L..... The situation of London on the Earth's Disc, as seen from the Sun at the time of Venus's total Egress as seen from the Earth's center.  
L d..... Venus's Parallax in Longitude =  $16^{\circ}$  Westward as seen from London at the time of her total Egress as seen from the Earth's center: and L f her Parallax in Latitude,  $14^{\circ} 2'$  at that time. Her Egress is invisible? at London?  
S..... The situation of S<sup>t</sup> Cruz Isle on the Earth's Disc as seen from the Sun at the time of Venus's total Egress as seen from the Earth's center: and s, the situation of s<sup>t</sup> Cruz when Venus's Egress from the Sun begins.  
S o..... Venus's Parallax in Longitude =  $11^{\circ} \frac{1}{2}$  Eastward, as seen from S<sup>t</sup> Cruz at the time of Venus's total Egress as seen from the Earth's center, & S m her Parallax in Latitude =  $8^{\circ} 2'$  at that time's North?  
s p..... Venus's Parallax in Longitude,  $10^{\circ} \frac{1}{2}$  Eastward, as seen from S<sup>t</sup> Cruz at the time when her Egress begins as seen from the Earth's Center, and s f her Parallax in Latitude =  $10^{\circ}$  southward at that time?

All these Parallaxes are measured on this Circle at the left hand and the times by which the total Ingress of Venus, & her beginning of Egress, are accelerated or retarded by her Parallax in Longitude are found in the Table, right against that Parallax. In eastern Parallax in Longitude retards the Ingress or Egress as seen from any given place with respect to the time thereof as seen from the Earth's center, and a western Parallax in Longitude accelerates it. A northern Parallax in Latitude retards the time of Ingress, as seen from any given place, & accelerates the time of Egress, by the number of Minutes that the half-transit line on the Sun's Disc is shorter as seen from the given place than as seen from the Earth's center, when Venus passeth above the Sun's center, as in this Transit: & a Southern Parallax in Latitude accelerates the Ingress, and retards the Egress, as seen from any given place, with respect to the time thereof as seen from the Earth's center, by the number of Minutes that the half-transit line on the Sun is longer as seen from the given place than as seen from the Earth's center. And those differences are found by measuring with Compasses in the above Figure of the Sun's Disc, from the Axis of Venus's Orbit to the Arc  $a d$  where Venus's center is at the instant of total Ingress; and to the Arc  $e d$  where her center is when her Egress begins. And thus, the times of total Ingress, and beginning of Egress, as seen from the above mentioned places, were found as expressed in the Table of the Times and Durations of the Transit.

As Venus moves from  $\text{V}$  to  $\text{v}$  in her Orbit,  $1^{\text{st}}$  Cruz moves the contrary way, from  $\text{S}$  to  $\text{s}$ , and Wardhays the same way, from  $\text{W}$  to  $\text{w}$ . When Venus is at  $\text{v}$  in her Orbit, she will appear on the Sun at  $\text{E}$ , at her beginning of Eclip<sup>s</sup>, as seen from the Earth's center; but at that time, she will be quite  $\frac{1}{2}$  dear of the Sun, in the line  $\text{s v O}$ , as seen from  $1^{\text{st}}$  Cruz then at  $\text{S}$ ; and as seen from Wardhays, then at  $\text{w}$ , she will appear on the Sun at  $\text{a}$ ,  $\frac{1}{2}$  short of her beginning of Eclip<sup>s</sup>, which will be later at Wardhays and sooner at  $1^{\text{st}}$  Cruz, than as seen from the Earth's center.

	D. H. M. S.
1. <i>The time at Greenwich of Conjunction of the Sun &amp; Venus June 2</i> .....	3.10.11.0 P.M.
2. <i>Their true Places in the Ecliptic then as seen from the Earth's center</i> .....	2.13.26.51
3. <i>The Sun's Declination North</i> .....	22.27.20
4. <i>The Place of Venus's ascending Node</i> .....	2.14.36.14
5. <i>Her geocentric Latitude at that time North Descending</i> .....	40.22
6. <i>The angle of her visible path with the Ecliptic</i> .....	8.30.10
7. <i>Her geocentric hourly motion on (or from) the Sun</i> .....	3.59½
8. <i>The Sun's distance from the Earth</i> .....	101523
9. <i>Venus's distance from the Sun</i> .....	79227
10. <i>Her distance from the Earth</i> .....	28896

*The Sun's mean distance from the Earth's center being 100000 of such parts*

**EXPLANATION.** In this Diagram  $S \& W W$  represents the Earth which turns on its Axis according to the order of the Letters. When Venus is in her Orbit at  $N$ , she will appear upon the Sun at  $I$ , at her total Ingrefs, as seen from the Earth's center, but at the same time, as seen from  $N$ ,  $I$  or  $E$ z Sole at  $S$ , she will be in the line  $S V N$ , not entered upon the Sun; and as then seen from Wardhuys at  $W$ , she will appear to be advanced upon the Sun at  $m$ , so that her total Ingrefs will be sooner, as seen from Wardhuys, & later, as seen from  $N$ ,  $O$ uz, than as seen from the Earth's center.